Seasonal characterization of dugong feeding and biomass utilization on selected sites in Talibong Island

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ABSTRACT
Dugong (*Dugong dugon*) is an herbivorous marine mammal and feeds almost exclusively on sea grass. Previous observation of the dugong feeding behavior revealed that they feed even at intertidal flats where the sea grass beds are completely exposed in the air during low tide and also at other deeper sites, where the tidal range is about 2-6m. We used a passive acoustic monitoring system to monitor their feeding behavior. Dugongs' feeding sounds were collected at two feeding grounds at an intertidal flat and a deep site. From the result of the comparison of feeding events during daytime to nighttime, we found dugongs mainly feed during the night (Welch t-test $p<0.05$). We also collected sea grasses at each feeding ground and compared the species composition of sea grasses and density of sea grass between the two sites. We calculated the feeding efficiency from the density of sea grass before and after dugong's feeding at each site and compared to them. These comparisons revealed that there was no significant difference in the amount of sea grasses fed upon by dugong between the two feeding grounds.

KEYWORDS : seagrass bed, passive acoustic monitoring, feeding event, feeding efficiency

INTRODUCTION

Dugong *Dugong dugon* is an herbivorous marine mammal inhabiting tropical and subtropical shallow waters. Dugongs feed almost exclusively on marine angiosperms of the families *Potamogetonaceae* and *Hydrocharitaceae* (Heinshon and Birch 1972). They are categorized as vulnerable to extinction (IUCN 2007). The major threats to dugongs along the Andaman cost are the incidental catch of dugongs in fishing nets and the destroying of sea grass beds (Hines 2002, Roberts and Hawkins 1999). The sea grass beds develop in shallow water areas and we need to protect these areas. However, these areas are also important fishery areas, so we need equally balanced conservation measures considering not only the dugong but also the fisherman. To establish such conservation measures, we should reveal the dugong's feeding behavior in sea grass beds.

The objects of our study are to answer the following questions.

- When do dugongs come to the intertidal flat to feed?
- How does tide affect the dugong's feeding behavior?

The study site was a sea grass area in an intertidal flat located in the eastern sea area surrounding Talibong Island, Trang in Thailand (N7°14′00.7″, E99°26′50.1″) (Fig.1).

The surveyed plot is 30 by 30 m^2 and the depth of this area is 0-2.5 m. The date of our study was from February 22 to March 5 and from November 8 to 23, 2006.

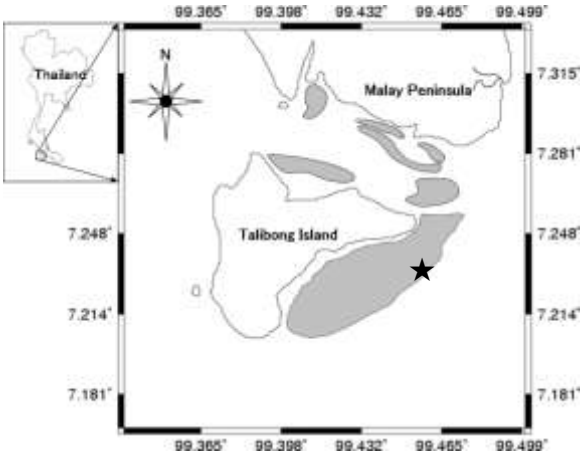

Fig.1 The study site (revised from Nakanishi *et. al.* (2005)). Black star shows the study site. Gray area shows sea grass area.

MATERIALS AND METHODS

The survey area was 30×30 m^2. We randomly collected quadrate samples of sea grasses with

20×20 cm^2 quadrate to calculate the dry mass density in the area. At the same time, we mapped positions of the dugong feeding trails and also measured the length and width of them almost every day, and counted the number of new trails. We collected sea grasses with 5×5 cm^2 quadrate from the inside and outside of new trails and calculated the feeding efficiency by Eq.1.

$$\text{feeding efficiency} = \frac{I_b - R_b}{I_b} \times 100 \quad \text{(Eq. 1)}$$

Where I_b is initial biomass outside of each trail and R_b is remaining biomass, which is biomass left inside the trail.

The feeding amount per trail was computed by multiplying the mass density by feeding efficiencies and areas of each trail. We compared trail numbers made per day and feeding amount per trail between neap tide and spring tide.

We used a passive acoustic monitoring system to monitor dugong feeding behavior (Ichikawa *et. al.* 2006, Tsutsumi *et. al.* 2006). The passive acoustic monitoring system was developed to observe animal behavior by monitoring the sounds which they produce. This system can closely and continuously monitor feeding behavior of dugong. We used an Automatic Underwater Sound System for Dugongs (AUSOMS-15, made by SIT) as acoustic recorder. We installed 2 sets of AUSOMS-15 under ground at the center of each of the survey areas. An experienced analyst discerned the collected sounds and counted the number of feeding events per 30 minutes. A feeding event was defined as a unit of successive feeding sounds in which the interval was within 8s (Tsutsumi 2006).

RESULTS AND DISCUSSION

The study site was dominated by mainly three sea grass species, *Halophila ovalis*, *Cymodocea serrulata*, and *Halodule pinifolia*. In February 2006, the dry season, the average dry mass density was 95.0 g/m^2 (*Halophila ovalis* 79.5 g/m^2, *Cymodocea serrulata a* 13.0 g/m^2, and *Halodule pinifolia* 2.5 g/m^2) and in November, the rainy season, 76.2 g/m^2 (*Halophila ovalis* 61.0 g/m^2, *Cymodocea serrulata* 13.1 g/m^2, and *Halodule pinifolia* 2.1 g/m^2). The average feeding efficiency was 80.6 % in February 2006 and 61.6 % in November. It is considered that the dugongs' feeding efficiency increases in the dry season with increase in seagrasses.

During neap tide, 6.3±3.9 trails were made per day and the feeding amount per trail was 14.7±11.2g. During spring tide, 15.8±5.9 trails were made per day and the feeding amount per trail was 13.5±9.7g. The number of the feeding trails per day in neap tide is significantly fewer than that in spring tide (t-test $p<0.05$). The feeding amounts per trail each time were equal (t-test $p<0.05$). These results suggest dugongs more often came to the feeding ground during spring tide than neap tide.

Total numbers of the feeding events obtained during each survey period, February 22 - March 5 and November 8 -13, 2006, were 639 and 549 hours, respectively. Figure 2 shows the time series change of the number of feeding events and depth during March 1 - 4, 2006. Figure 3 shows the result of the comparison of feeding events during daytime to nighttime. Dugongs feed more often in nighttime (Welch t-test $p<0.05$).

According to the comparison result of feeding events during daytime to nighttime, dugongs fed more often in nighttimes. That is to say intensive protection in nighttime is recommended around this intertidal flat.

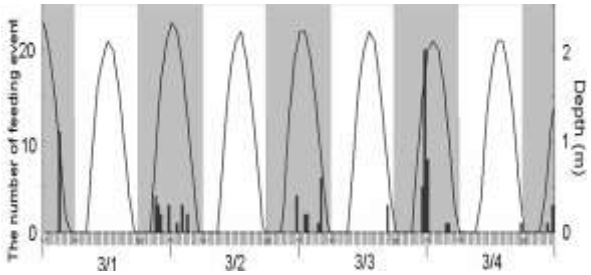

Fig.2 time series change of the number of feeding events and depth during March 1 - 4, 2006. The line shows depth change and bar shows the number of feeding events for 30 minutes. Shaded zone shows nighttime.

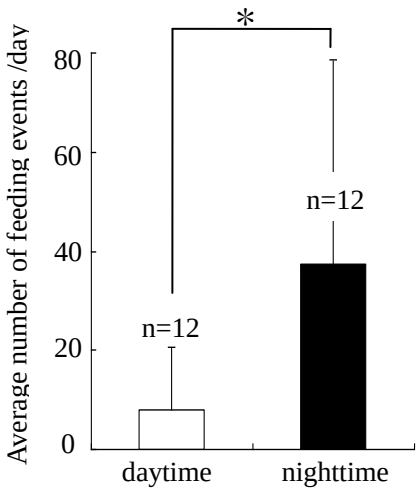

Fig.3 Average number of feeding events per day. White bar shows daytime and black bar shows nighttime.

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